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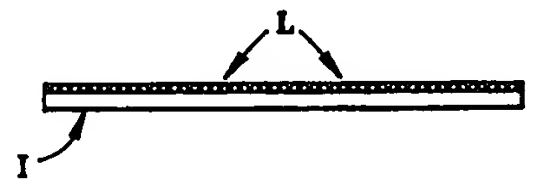
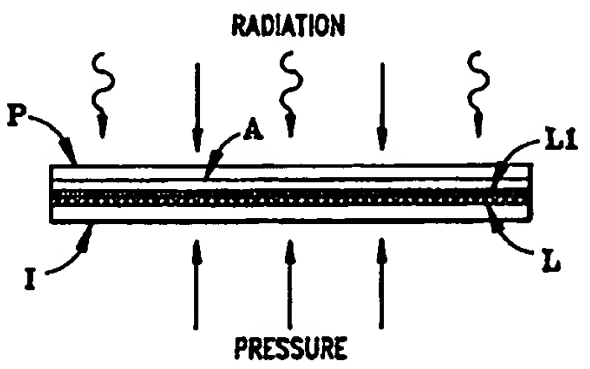
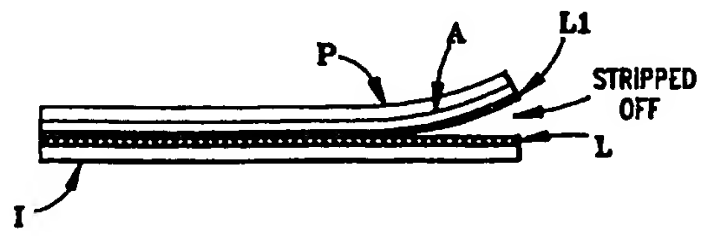
(54) Title: A METHOD OF PRODUCING EMBOSSE, LIGHT-DIFFRACTING PATTERNS

(57) Abstract

A method of producing on a substrate surface (P) predetermined, multi-colour diffraction/refraction patterns or hologram (L), where the said method comprises: applying a radiation-curable adhesive coating (A) between a flexible film master (I) and the substrate surface; pressing the flexible film master and the substrate together with the coating (A) interposed in order to cause the surface of the coating adjacent the film master to become impressed with a faithful reproduction of the predetermined pattern (L) of the film master; radiation-curing the adhesive coating in order to set the impressed pattern (L) in the coating surface, while integrally bonding the coating to the substrate surface; and stripping the resulting integral, patterned, coated substrate from the flexible film master. The film master may also be metallised, in which case the metal layer is adhered to the substrate in order to generate additional decorative effects.







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A METHOD OF PRODUCING EMBOSSE, LIGHT-DIFFRACTING PATTERNS

The present invention relates to papers and similar substrates bearing embossed light-diffracting and holographic type fine line multi-color prism-like refracting surface patterns and images; being more particularly directed to novel methods of manufacturing such papers, boards and other substrates without requiring the laminating of decorative embossed-pattern surfaces thereupon, and to improved and less expensive single integral film or sheet substrates of this character.

Background

The art is replete with processes for laminating thin sheets to paper and paper-like surfaces, including metallized layers, upon which patterns or images or other data have been impressed or transferred from surfaces containing such patterns or images or the like.

Coatings providing smooth and other surfaces and metallized film layers and the like have also been provided upon paper-like surfaces, and adhered thereto by ultraviolet (u.v.) and electron beam (e.b.) radiation-curable adhesive coatings , such as described, for example, in U.S. Patents Nos. 4,490,409 and 4,246,297. The latter, for example, have been widely used for glossy decorative paper wrappings and similar applications.

Relatively recent interest in holography and in intricate light-refracting and diffracting surface patterns in general has enabled the producing of unique multi-faceted varied color surface effects on paper, board and other substrates that not only are highly decorate but, for important useages where duplication is not desired (currency, stock or

bond certificates, credit cards, etc.), cannot be faithfully copied on xerographic reproducing machines, or otherwise easily counterfeited. The prior art layering or laminating of light-diffracting films or layers to paper or other substrates, and similar processes used to achieve these results, however, are relatively expensive and require multiple steps of fabrication.

The use of metallized papers, adapted for printing, has been expanding for a variety of applications, including printable product labels and the like, and with the high-quality glossy decorative appearance rendering them most desirable also for gift wrappings, packaging, gift bags and other uses. Light interference surface effects have been produced by embossing fine lines into a coated layer on paper and then metallizing the embossed surface to give rise to prism-like multi-color refraction and diffraction effects, producing predetermined patterns and images, including holographic images, where desired, and that present changing shiny, multi-color mirror-like effects at different viewing angles.

Such papers have heretofore been produced by applying a thin layer of pre-lacquer to the base paper, drying the lacquer to a hard finish, and embossing the lacquered surface by conventional embossing rotary metal dies, under heat and pressure. The dried paper is then introduced into a metallizing vacuum chamber where a very thin layer of aluminum or other metal (say 2 millionths of an inch or so) is deposited to metal-coat the embossed lines so as to provide a metallized light-reflecting line pattern, The metallized paper is then returned to the coater station where the paper is top-coated with a print primer and remoisturized, in view of the earlier layer drying, as described, for example, in the 1994 bulletin of van Leer Metallized Products of Franklin, Massachusetts, entitled Illuminations.

As further explained in the Van Leer 1996 Holo PRISM ™ bulletin,. optimally to produce light-diffraction gratings and similar optically ruled or otherwise engraved or cut fine line surface patterns, a line spacing of the order of about 25,000 per inch will generate optimal prism-like multi-color light diffraction and holographic images or patterns and the like.

Underlying the present invention, on the other hand, is the discovery of how the appropriate use of e.b. curable adhesive thin layer coatings on paper and similar substrates, and/or u.v. in some cases, can enable the direct and inexpensive, but highly faithfully reproduced transfer of intricate diffracting-refracting and holographic surface prismatic embossings from thin flexible embossed film or web masters, and without requiring the use of any additional embossing metal dies, or separate fabrication steps, or top coats, or paper remoisturizing, or layer laminations on the substrates.

Objects of Invention

An object of the invention, accordingly, is to provide a new and improved method of directly transferring to paper, board and other substrates and the like, the fine-line patterns of light diffracting - refracting and holographic images, and with a relatively low-cost u.v. or e.b.- curable coating pattern or image transfer technique using preferably an appropriate flexible pattern-embossed film web master.

A further object is to provide improved diffracting, refracting and/or holographic products produced by such method.

Other and further objects will be explained hereinafter and are more particularly delineated in the appended claims.

Summary

In summary, however, from one of its important aspects, and where metallizing is not involved, the invention embraces a method of producing on a substrate surface predetermined multi-color diffraction-refraction effects and patterns, that comprises, applying between a flexible film master, provided with an embossed predetermined diffraction pattern formed of fine lines, and a substrate surface, a radiation-curable adhesive coating material of a type that, when radiation cured, will integrally bond to the substrate surface but not to the material of the embossed film master; pressing the flexible film master and substrate together with the coating interposed to cause the surface of the coating adjacent the embossed film master to become impressed with a faithful reproduction of the predetermined fine line diffraction pattern of the film master; radiation-curing the adhesive coating to set the impressed diffraction pattern in said coating surface upon the radiation-curing of the coating, while integrally bonding the coating to the substrate surface; and stripping the resulting integral diffraction-patterned coated substrate from the flexible film master.

The invention also is most useful where the film master has been metallized and the metal layer is adhered to the paper to generate even more spectacular shiny multi-colored effects.

Best mode and preferred embodiments and designs and products will hereinafter be more fully detailed.

Drawings

The invention will now be described with reference to the accompanying drawings, Figs. 1A, B and C of which are side elevations of successive steps in the preferred method

or process of the invention, as applied to non-metallized substrate applications, resulting in the stripped-away novel single-sheet product of Fig. 1C;

Figs. 2A and 2B are similar views in which the embossing film master is metallized to provide an embossed metal layer for transfer to the paper or other substrate product;

Fig. 2C and Figs. 2D and E are similar views of modified metallizing sequences;

Fig. 3 is a schematic diagram of a suitable in-line manufacturing system for producing the product; and

Figs. 4-7, are photographs showing the vibrant effects produced with both unmetallized and metallized products of the invention.

Description of Preferred Embodiment(s)

One of the discoveries underlying the present invention, totally obviates the need and, indeed, the complications of applying metal die and rotary drum embossing systems to the ultimate paper or other substrate product. Surprisingly, it has been found that thin flexible films carrying embossed, engraved or otherwise cut or formed diffraction fine line pattern(s) or images, (all generically embraced by the terms "embossing" or "embossed" herein), can themselves be used as the embossing master. As above discussed, the embossed diffraction patterns are of fine lines, preferably, though not always essentially, of the order of about 25,000 per inch, to achieve the full preferred ultimate diffraction-refraction prism-like multi-colored effects herein desired on the product surface. In accordance with the preferred practice of the invention, these lines forming the desired diffraction patterns, are carried on a surface of a preferably relatively thin flexible plastic film or sheet master I, Fig. 1A, as of polyolefin plastic film such as polypropylene or appropriate polyesters, of the order, generally, in the range of about 48 gauge to 142

gauge. The thickness is sufficient to permit the embossing of the very fine line patterns L, by any desired technique, into the film master. For artistic patterns, the lines may diverge at various angles and have varying depths to provide the prism-like refraction-diffraction effects; and, where desired, holographic image effects, achieving different colors, brightnesses and depths as viewed from different angles of incidence. The flexible film master, must be thick enough to permit the embossing or forming into one of its surfaces of such refraction-diffraction fine lines or rulings, but preferably, however, not thinner than about the order of 70 gauge in the case of polypropylene or 48 gauge in the case of polyester, for example, to enable best use of the transfer process of the invention.

In Fig. 1B, a paper substrate P, ranging, for example, from thin papers to, say, 26-point board or the like, (where the term "paper" is used herein generically to embrace all papers and boards and the like) has been coated on one side or surface with a thin e.b. or u.v.-curable adhesive layer A, such as a radiation-curable epoxy acrylate or urethane acrylate or the like, say, of the order about 0.0625 -0.625 mils in thickness (1-10 pounds per 3000 ft^2). Alternatively, the embossed side of the flexible film master 1 may be so coated.

The substrate P and film master I, with the interposed applied coating A therebetween, are flexibly pressed together to insure that the surface of the adhesive coating material A adjacent the film master faithfully fills and becomes impressed by the diffraction-refraction lines L in the flexible film master I. Upon radiation curing, so labeled, under such continued contact, as by passing the pressed-together flexible film master I and the substrate P with the interposed coating A under a curing station R, Fig. 3, (e.b. of, for example, about 120-300 kilovolts (KV) and a dose of about 2-5 megarads, as with, for example, an Energy Sciences Model EC125/180/1050 electron beam machine, or about a 300-600 watts/inch

u.v. station as with a Fusion Model of VMPE-8/7(F600V), the thin interposed layer A cures, permanently setting or casting a faithful reproduction of the embossed diffraction pattern L in the adjacent cured coating surface at L1, Fig. 1C, and bonding the coating to the substrate P. The properties of the material of the film web master I and the coating A must be selected, however, such that the cured coating A will not bond to the film master I, so that the integral product P-A, with the cured coating now fixedly set and impressed with pattern L1, may be readily released or stripped away from the film master 1, as shown in Fig. 1C.

It has been found that such a product has become extremely faithfully imbued with the same diffraction-refraction and/or holographic imaging properties as the original embossed film master, achieving a low cost single sheet diffracting paper with the desired multi-color prism-like effects.

Examples of suitable embossable thin flexible film master materials, such as preferred plastic polyolefins of polypropylene and polyurethane and the polyester films, were noted above; but there are other plastics and other materials, such as polyethylene, that though physically not readily directly engravable or embossable to serve as an embossing film master, can be adapted for such purpose. The present invention enables such adaptation of normally non-embossable films or sheets for such use through the use of the curable adhesive coating of the invention and the pressing against a suitable master film while curing the adhesive – in this case, an adhesive of the type curable to adhere or bond integrally to the polyethylene to provide it with an integral embossed diffraction pattern surface, but not adherable to the master web, so that the coated polyethylene may be stripped away

therefrom after the curing. A suitable adhesive coating for this purpose would be SUN P87-2012 urethane acrylate.

With the type of radiation-curable acrylate adhesives above discussed, the cured coating with its inherent transferred cast-embossed pattern may be clear and transparent, providing the more subdued diffraction-refraction multi-color pattern effects for the single sheet paper substrate, as compared with more vibrant metallized versions, as later-discussed. Where desired, however, the coating may be pigmented or tinted, as by the use of TiO_2 or the like in the coating material, enabling different color effects where desired as shown in Fig. 4.

Other suitable radiation-curable adhesive coatings for the purposes of the invention include polyesters, urethanes, epoxies and pre-radical and cationic curable materials. A useful coating is JRX-1082 Quretech urethane acrylate adhesive. Other master mold web films or sheets than plastic films may include thin metal foil or the like. Other substrates than paper and board include textiles, non-woven fabrics, plastic films such as nylons, vinyls and polyethylene, and even metals foils or other substrates, and such are all generically referred to herein as "substrates" or substrate surfaces or the like.

Turning to the added use of metallization, with its more vibrant shiny effects, there are three alternative procedures that can be used with the techniques of the invention.

First, the embossed film master 1 of Fig. 1A may be metallized, as before described, by using a vacuum deposition chamber, that deposits a very thin layer of metal, following the pattern of the embossed diffraction pattern lines L of the film master I, as shown in Fig. 2A at M, and reproducing the diffraction pattern L2 on the inner surface of the metal deposit M adjacent the film line pattern L. The outer surface of the metal layer

may then be coated with the radiation-curable adhesive A of the invention, pressed against the paper or other substrate P and cured, with the resulting stripped off product P-M, Fig. 2B, having the extraordinary shiny prism-like and/or holographic effects.

The invention, furthermore, permits selective transfer of patterns, words or images by printing, or applying the coating selectively. Fig. 7, later more fully discussed, shows the results of such selective coating printing in the process of Figs. 2A and 2B. The cured coating, moreover, may be printable, scorable, gluable, die-cuttable, etc., in all cases.

Secondly, following the technique of Figs. 1A-C, the embossed film master 1 may be coated with the radiation-curable adhesive A (or the paper or other substrate P may be so-coated) and again pressed together with the substrate P, followed by radiation curing of the intermediate adhesive layer A, Fig. 1B, and then stripping from the film, as in Fig. 1C. The resulting impressed embossed diffraction pattern transferred to the cured coating A may then be metallized at M, Fig. 2C, to create the shiny vibrant diffraction effects of the resulting "embossed" mirror-like reflecting metal surface of the substrate.

Thirdly, the paper or other substrate P may be metallized at M, Fig. 2D, and coated with the radiation-curable adhesive layer A' (or the embossed film master 1 may be so coated at A), with the film and metallized or foil laminated paper pressed together and the coating radiation-cured, as before, and stripped away from the film as in Fig. 2E.

Suitable apparatus is shown in Fig. 3 for in-line production with the flexible embossed flexible film master web 1, unwinding from an unwind roll #1, and the paper or other substrate web P unwinding from roll #2 and then, after coating of the web master I, in this case, with the radiation-curable coating at a roll coater station C, passing to a nip station N, for pressing together with the film master coated web I before passing under the

radiation curing station R. This is followed, then, by stripping the product P-A from the film web 1 at S, and rewinding the product at rewind #2, and the film master web at rewind #1. The paper may be treated at a corona station before coating, as shown. The film web may then be re-used as a master.

The techniques of the invention, as before pointed out, achieve these desirable diffracting surfaces or substrates without requiring the ultimate paper or other substrate to be subjected to conventional embossing or engraving dies and procedures and with a single step operation that does not dry the paper or other substrate and thus does not require remoisturizing nor the use of a top coat, and that can avoid laminating metallized or other diffraction surfaces to the paper, board or other substrate.

The non-lamination-based manufacturing process of the invention thus provides unique single-sheet diffraction-refraction and holographic papers and the like useful particularly for the printing and packaging industries and elsewhere, as well. A high-gloss and attractive holographic surface is providable useful with all grades of papers and board (up to about 26 pts. thick, for example), and can be printed upon by standard methods, offering a new high-visibility alternate for cartons, labels, bags, cards, POP displays and advertisements, among other applications. The novel product, as before explained, is of relatively low cost, as compared with prior and other laminated products, and is durable and aesthetically appealing – and since it is not a laminate, nor been subjected to drying heat, maintains excellent lay-flat characteristics, with ready printibility and convertibility. The invention thus provides a most cost effective way to decorate paper or board or similar substrates. As before pointed out, a wide variety of substrates may be thus decorated and in varying widths, up to, say, 60 inches wide; and with a variety of

substrates, including, for example, a 30-pound (48 g/sm) paper and upwards (MF, MG, MC papers), clay coated papers (40 pounds and upward), C/1/SSBS board and/or C/2SSBS board (8pt. - 26 pt), wet-strength papers (40 pounds and upward), and others, and with metallized, clear and pigmented surfaces, as desired.

As before mentioned, the photograph of Fig. 4 shows both a clear prismatic paper manufactured by transferring the prismatic pattern from a prismatic film master, using the technique of Figs. 1B and 1C, and the same with a red-tinted adhesive coating.

Fig. 5 shows a prismatic dark paper manufactured by transferring the metal layer from a metallized prismatic embossed film in accordance with the technique of Figs. 2A and 2B.

Fig. 6 shows a clear prismatic black paper manufactured by transferring the prismatic pattern from a clear prismatic film master; and

Fig. 7 shows selectively metallized prismatic white paper manufactured by selectively printing the adhesive in the desired pattern on the prismatic film master, pressing to the paper, and curing and stripping away the partially de-metallized film master from the paper (see "void").

The invention also provides a low cost technique for reproducing ruled diffraction grating patterns and the like on paper and similar substrates from a flexible film master.

Further modifications will also occur to those skilled in this art and such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

Claims:

1. A method of producing on a substrate surface any of predetermined multi-color diffraction-refraction effects, patterns and holograms, that comprises, applying between a flexible film master provided with an embossed predetermined diffraction pattern formed of fine lines and a substrate surface, a radiation-curable adhesive coating material being of a type that, when radiation cured, will integrally bond to the substrate surface, but not to the material of the embossed film master; pressing the flexible film master and substrate together with the coating interposed to cause the surface of the coating adjacent the embossed film master to become impressed with a faithful reproduction of the predetermined fine line diffraction pattern of the film master; radiation-curing the adhesive coating to set the impressed diffraction pattern in said coating surface upon the radiation-curing of the coating, while integrally bonding the coating to the substrate surface; and stripping the resulting integral diffraction-patterned coated substrate from the flexible film master.

2. A method as claimed in claim 1 and in which the coating material is applied to the substrate surface, before said pressing.

3. A method as claimed in claim 1 and in which the coating material is applied to the embossed film master before said pressing.

4. A method as claimed in claim 1 and in which the film master and substrate are in the form of flexible webs.

5. A method as claimed in claim 1 and in which the fine lines are spaced on the order of about 25,000 lines per inch.

6. A method as claimed in claim 1 and in which the film master comprises a flexible embossed plastic film web.

7. A method as claimed in claim 6 and in which the embossing has been provided directly into the film.

8. A method as claimed in claim 6 and in which the embossing has been provided in a coating carried by the film.

9. A method as claimed in claim 6 and in which the plastic film master is one of polypropylene, polyurethane, vinyl and polyester.

10. A method as claimed in claim 9 and in which the radiation is one of e.b. and u.v., and the adhesive coating is one of a radiation - curable acrylate, polyester, urethane, epoxy, pre-radical and cationic.

11.. A method as claimed in claim 1 and in which the radiation-curable adhesive coating is of the order of about 0.0625-0.625 mils in thickness, and the e.b., if used, is produced at voltages of the order of about 120-300KV at a dose of about 2-5 megarads, and the u.v., if used, is of the order of about 300-600 watts/inch.

12. A method as claimed in claim 4 and in which the film web master is of thickness of the order of from about 48 gauge to about 142 gauge.

13. A method as claimed in claim 1 and in which the substrate is selected from the group consisting of paper, board, textile, non-woven fabric, plastic and metal substrates.

14. A method as claimed in claim 10 and in which the acrylate coating is one of epoxy, urethane, polyester, and epoxy acrylate.

15. A method as claimed in claim 1 and in which the adhesive coating is one of clear, pigmented and tinted.

16. A method as claimed in claim 1 and in which the embossed film master is provided with a thin metallized deposit.

17. A paper-like metallized transfer product manufactured by the method of claim 16.

18. A paper-like transfer product manufactured by the method of claim 1.

19. A non-laminated single sheet substrate having a bonded radiation-cured coating on one surface into which coating is impressed and cast-cured one of fine-line diffraction, refraction, and holographic patterns.

20. A paper substrate as claimed in claim 19 and in which said coating has a metallized surface.

21. A paper substrate as claimed in claim 19 and in which the fine lines of the pattern are spaced at least about the order of 25,000 lines per inch.

22. A paper substrate as claimed in claim 19 and in which the cured coating is one of printable, scorable, die-cuttable and embossable.

23. A paper substrate as claimed in claim 19 and in which the coating is one of clear, pigmented and tinted.

24. A substrate as claimed in claim 19 and in which the substrate is selected from the group consisting of papers, board, textiles, non-woven fabric, plastic, metallized films and foils.

25. A paper substrate as claimed in claim 16 and in which the coating is a radiation-cured adhesive of acrylate.

26. A method of producing from a diffraction pattern-containing flexible master sheet, a corresponding diffraction pattern product on a substrate surface, that comprises, coating one of the surface and the sheet with a u.v. or e.b.- curable thin adhesive coating layer bondable, upon curing, to the surface, but not to the material of the sheet; pressing the surface against the diffraction grating pattern of the sheet to conform the intermediate coating layer to the diffraction pattern; curing the coating to bond the coating with the surface and to cast the diffraction pattern into the cured coating; and stripping the substrate with its cured diffraction pattern coating from the master sheet.

27. A method as claimed in claim 26 and in which the substrate is metallized.

28. A method of imbuing a film sheet, normally unsusceptible to embossing, with a surface having the fine line embossed pattern of an embossed pattern-contained flexible web, that comprises, coating one of said surface and the web with a radiation-curable thin adhesive coating layer bondable, upon curing, to said film sheet surface, but not to the material of the web; pressing the sheet surface against the web; radiation curing the coating; and stripping the sheet with its cured pattern coating from the web.

29. A method of producing on a substrate surface predetermined multi-color diffraction-refraction effects and patterns, that comprises, applying a thin metal deposit upon an embossed fine line diffraction patterned flexible film to conform an inner surface of the metal deposit to the fine line pattern; pressing the substrate surface against the outer surface of the metal deposit with a thin radiation-curable adhesive coating interposed therebetween, the coating being of the type that, when radiation cured, will integrally bond

with both the substrate surface and said metal deposit outer surface, radiation curing the adhesive coating; and stripping the resulting integral metal deposit - coating - substrate from the flexible film.

30. A method as claimed in claim 29 and in which the interposed adhesive coating is selectively printed or applied.

31. A metallized substrate manufactured by the method of claim 29.

32 A metallized substrate claim as claimed in claim 31 and in which the substrate is selected from the group consisting of paper, board, textile, non-woven fabric, plastic and metal sheets.

33.. A method of fine line diffraction pattern embossing, that comprises, providing a flexible thin film having a surface embossed with said pattern; applying a material to the embossed film surface that can faithfully fill the fine lines of the embossed pattern; applying a substrate backing to the applied material; solidifying the material within the film embossed pattern and adhering the material to the substrate backing; and stripping the backing with its adhered solidified material from the flexible film; the material presenting a transferred embossed pattern integral with the substrate.

34.. A method as claimed in claim 33 and in which the flexible thin film and substrate are provided in web form and the film web is flexibly pressed against the substrate web with the material interposed and flexibly stripped therefrom.

35. A method as claimed in claim 33 and in which the material is a radiation-curable adhesive coating interposed between the substrate and the film, and the solidifying and adhering are effected by radiation curing the material.

36. A method as claimed in claim 35 and in which the embossed pattern of the material is metallized.

37. A method as claimed in claim 35 and in which the material is a metallized deposit that solidifies in the fine line embossed pattern of the film.

38.. A method as claimed in claim 37 and in which the metallized deposit is adhered to the substrate backing by interposing a radiation-curable adhesive therebetween and radiation curing the same.

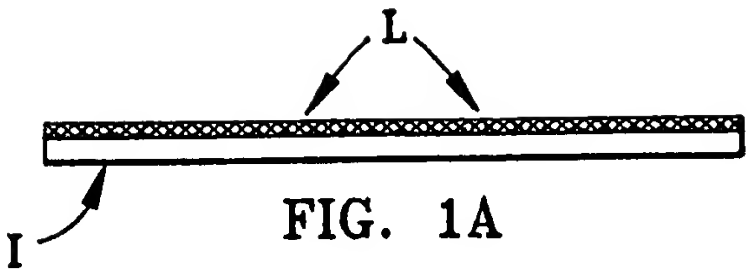

FIG. 1A

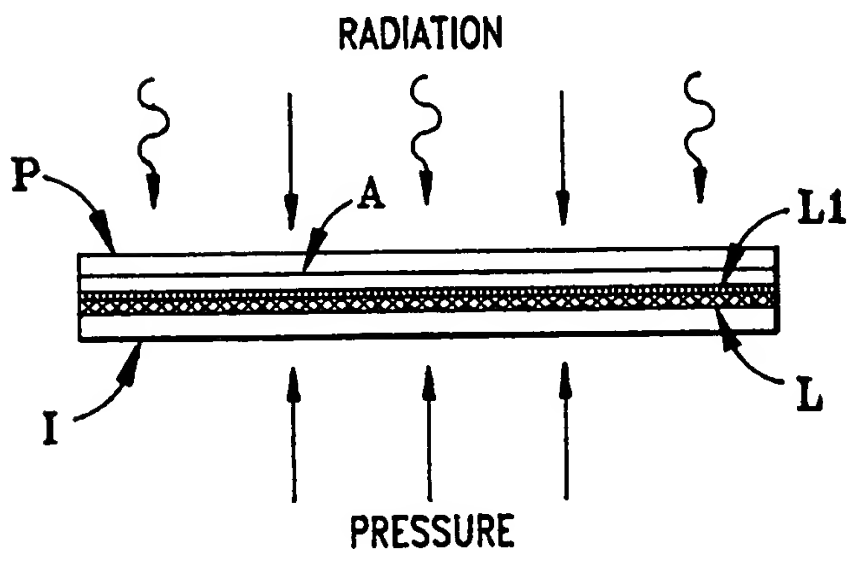

FIG. 1B

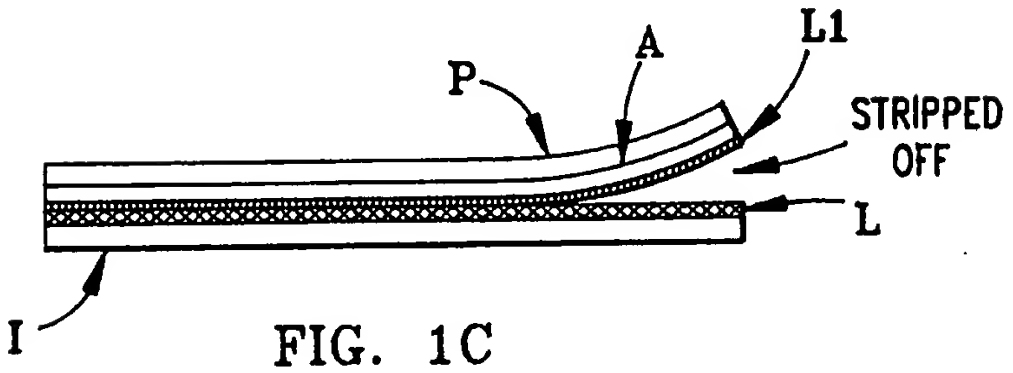

FIG. 1C

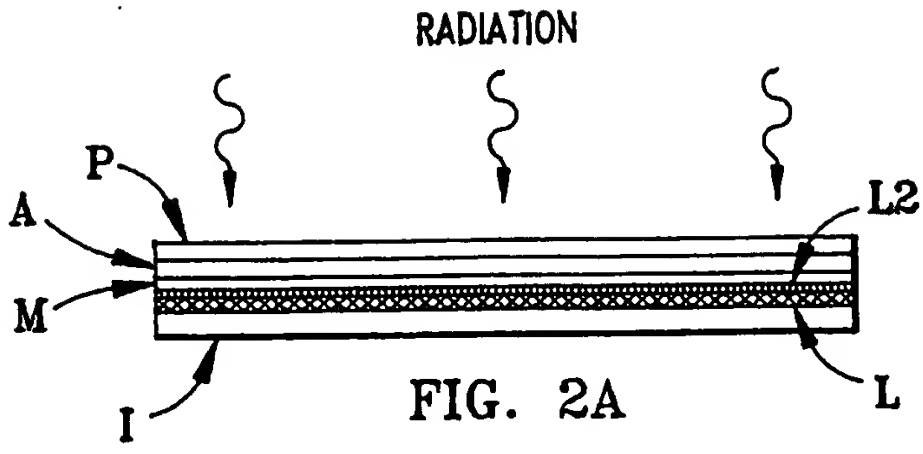

FIG. 2A

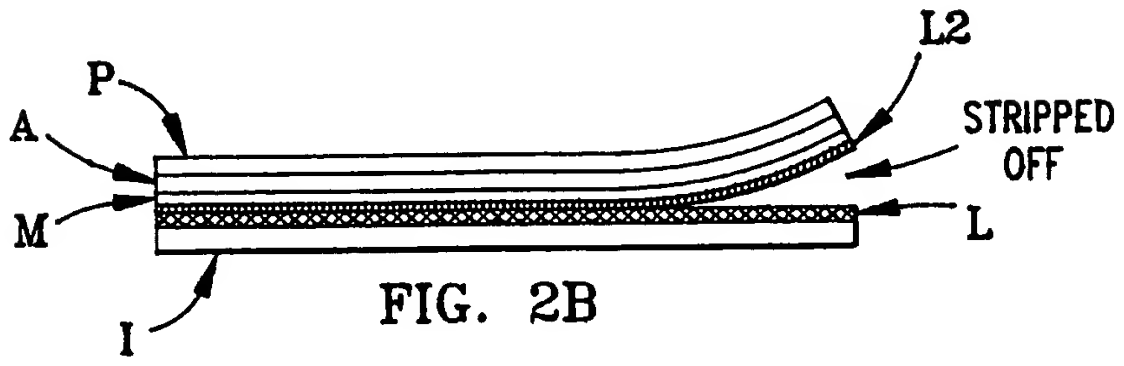

FIG. 2B

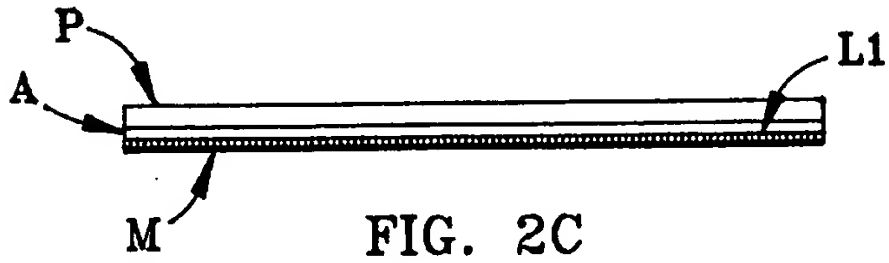

FIG. 2C

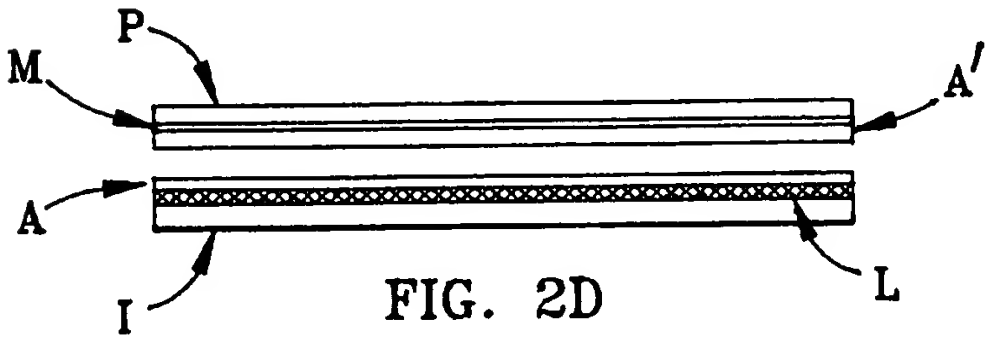

FIG. 2D

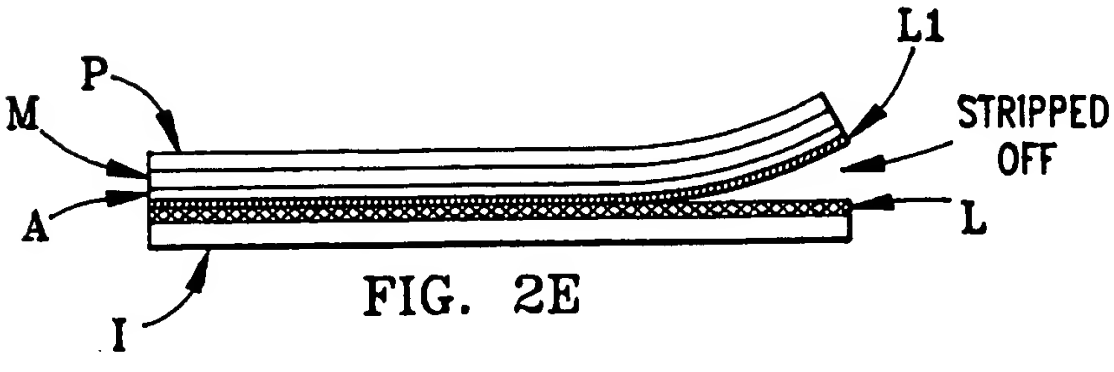

FIG. 2E

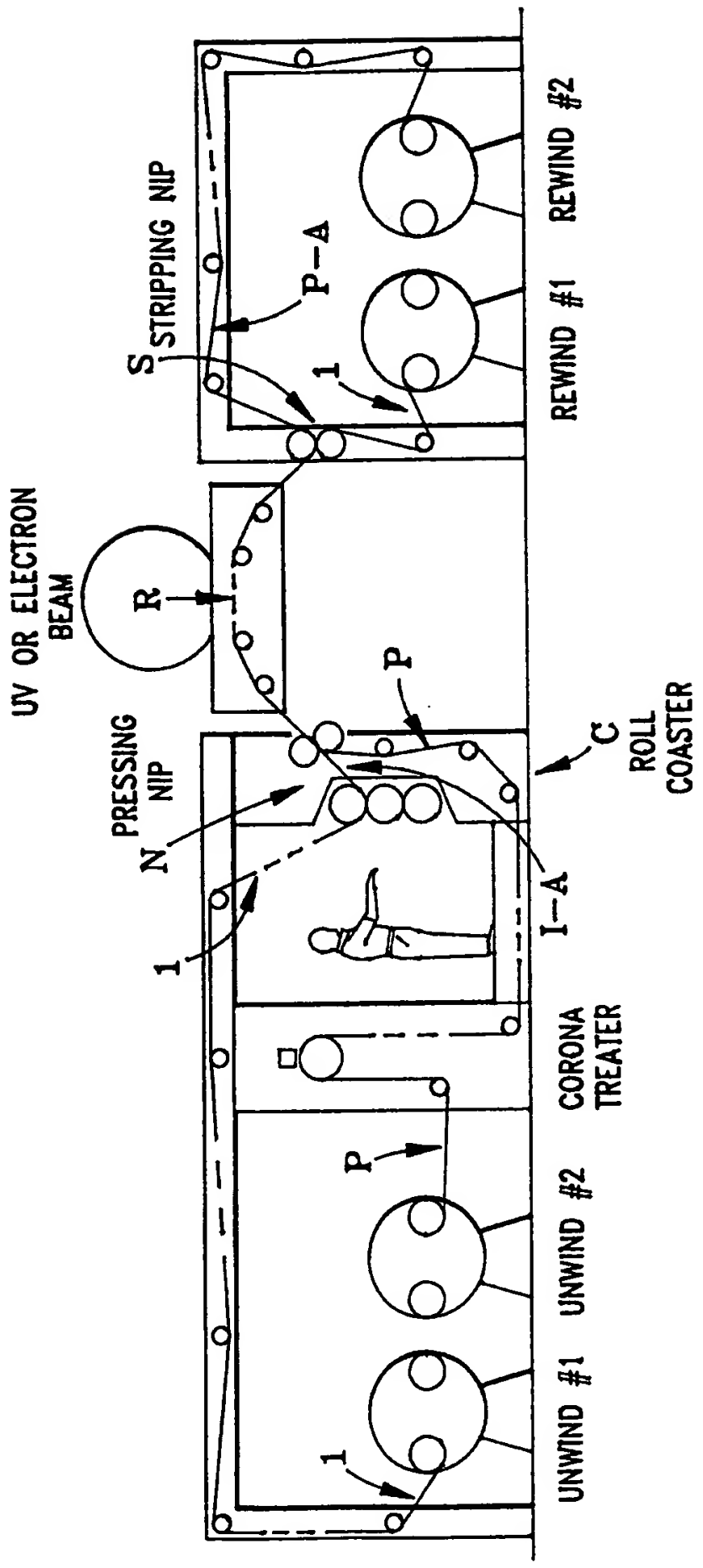
UV OR ELECTRON BEAM
R
PRESSING NIP
N
1
P
1
P
UNWIND #1
UNWIND #2
CORONA TREATER
P
I-A
C
ROLL COASTER
S
STRIPPING NIP
P-A
1
REWIND #1
REWIND #2

FIG. 3

FIG. 4

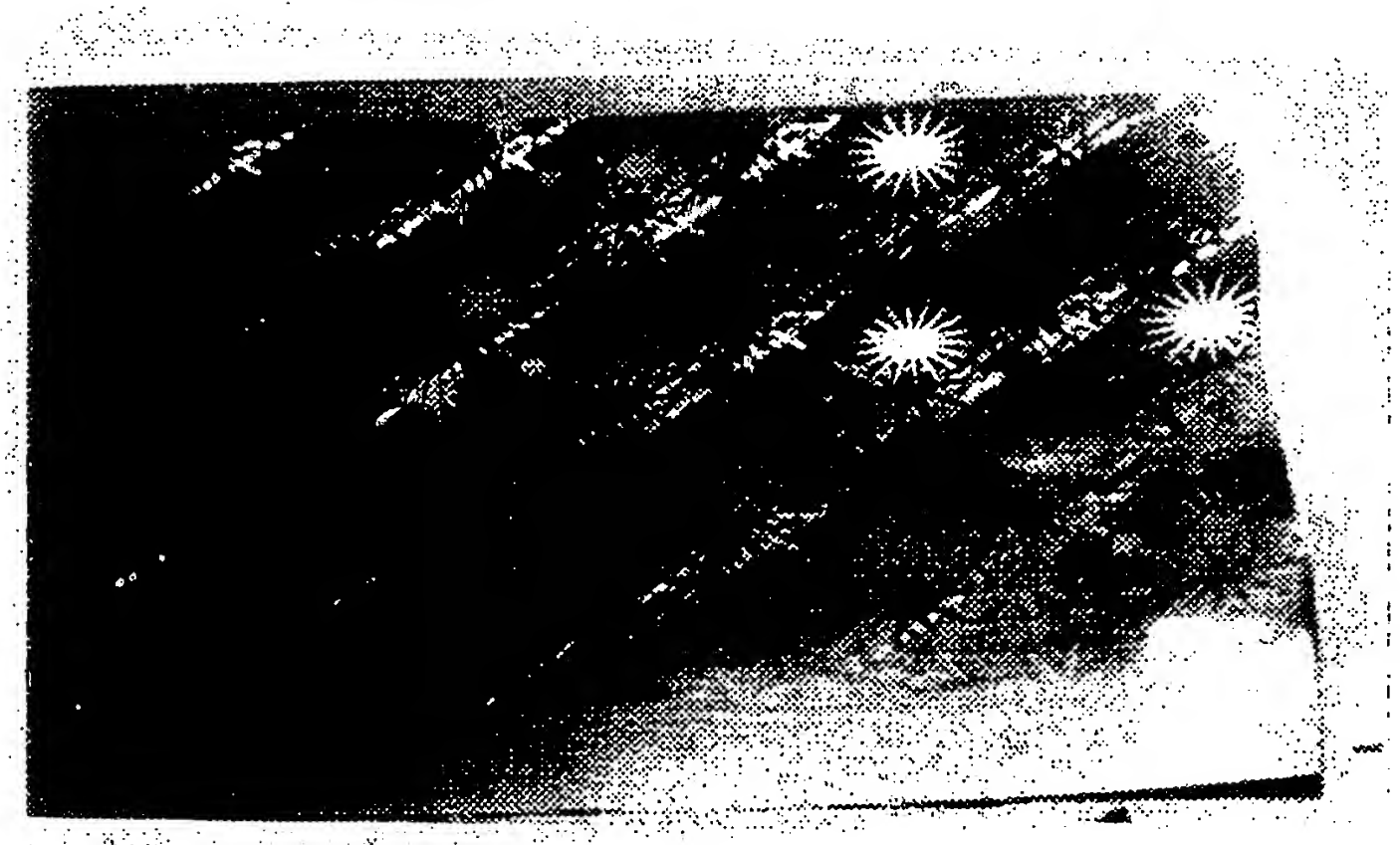

FIG. 5

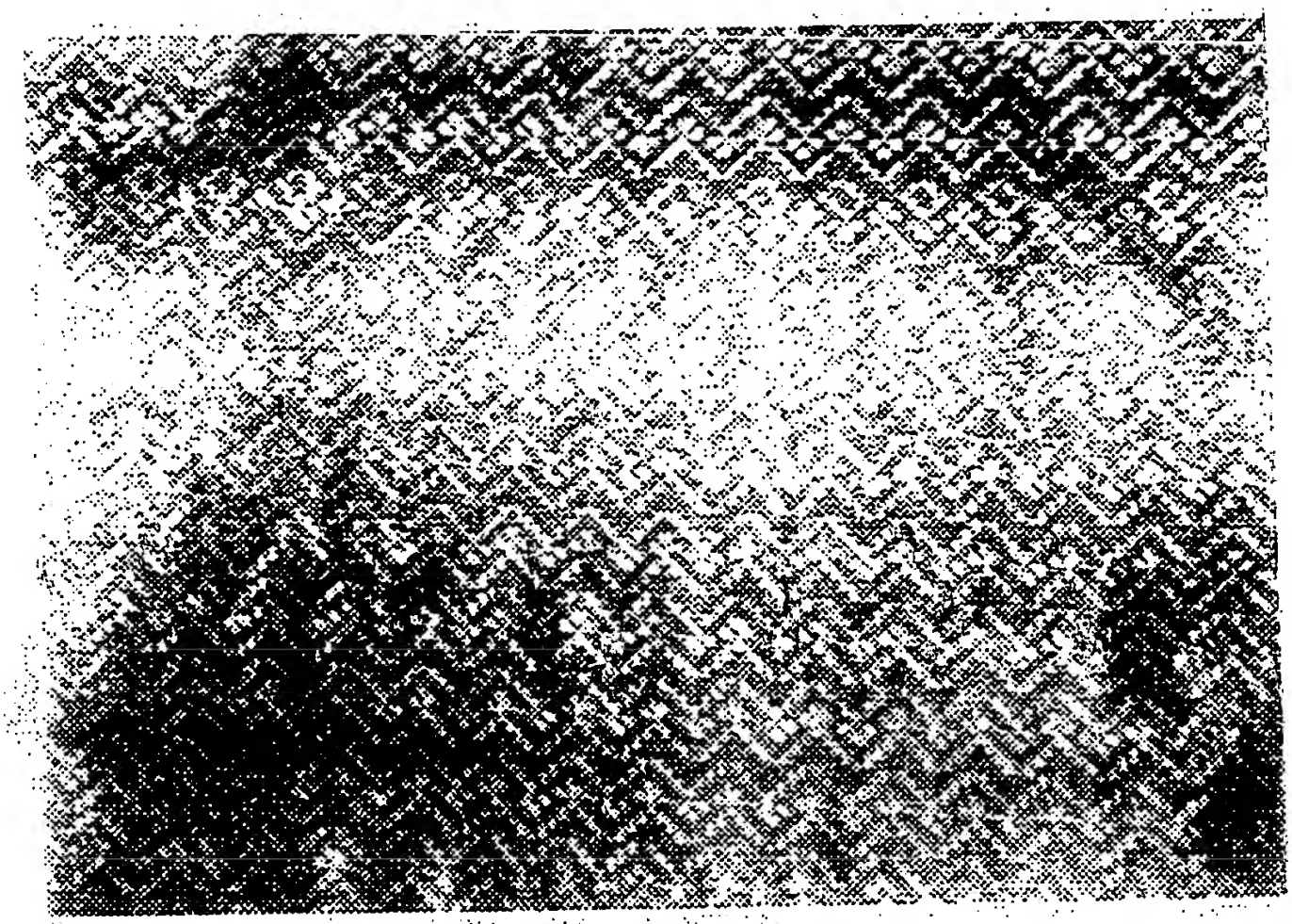

FIG. 6

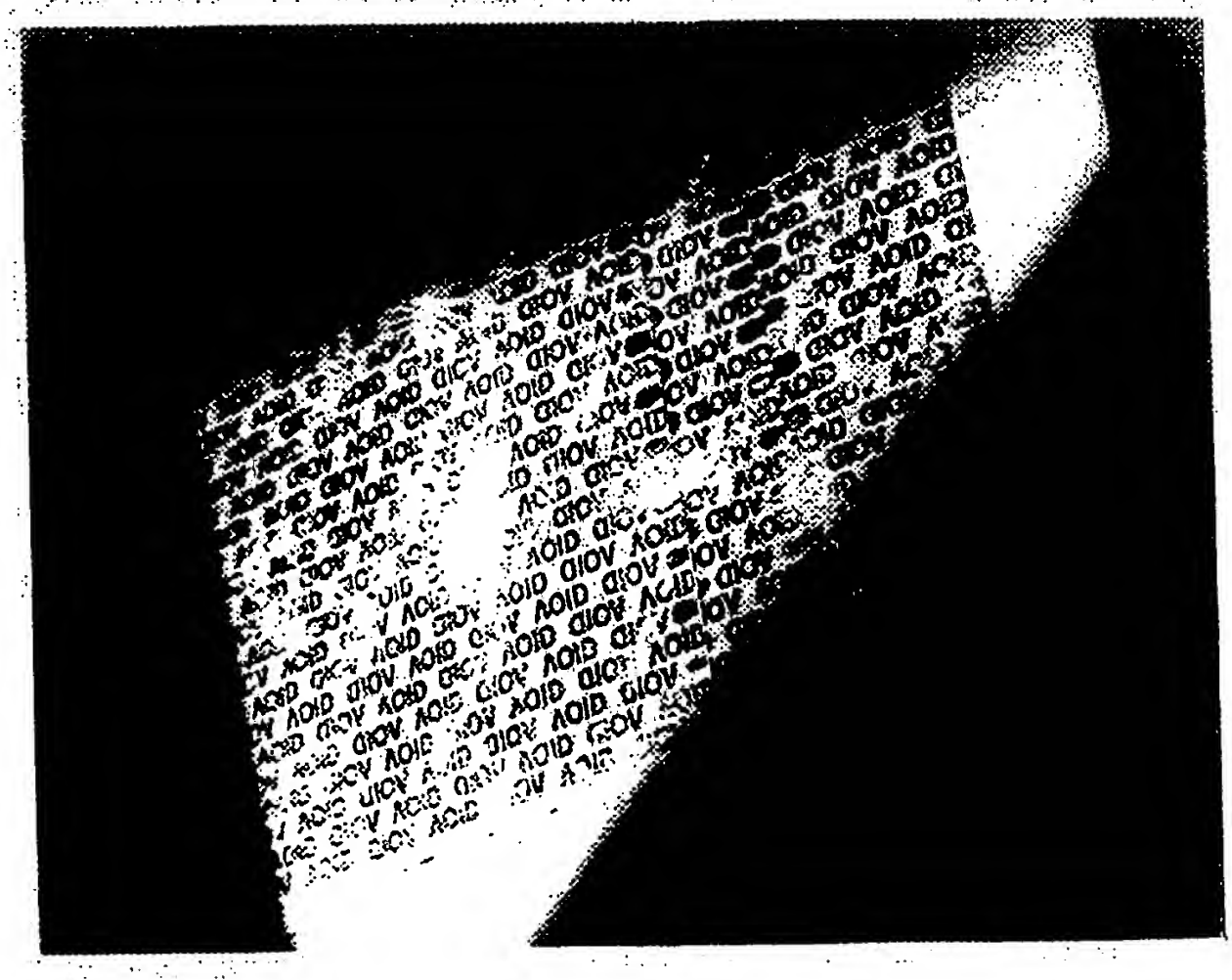

FIG. 7

INTERNATIONAL SEARCH REPORT

Interr ıal Application No
PCT/IB 97/00999

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G03H1/02 B29C39/14 B44C1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B44C G03H B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 758 296 (S. P. MCGREW) 19 July 1988 see column 1, line 36 - column 5, line 10 ---	1,3-7,9, 10,13, 15,18-24
X	US,A,5 543 228 (YUKIO TANIGUCHI ET AL) 6 August 1996 see column 2, line 45 - column 4, line 42; examples 1,2,4 see column 8, line 56 - column 9, line 16 --- -/--	1,2,5,6, 8-11, 13-15,19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 December 1997	27.03.98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	DOOLAN G.J.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Interr ɪal Application No
PCT/IB 97/00999

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 840 757 (G. P. BLENKHORN) 20 June 1989 see column 1, line 5 - column 2, line 39 see column 3, line 9 - column 5, line 33; examples 1,2	1-3,5, 11,13, 15,16, 19,21-25
X	EP,A,0 338 378 (AMERICAN BANK NOTE HOLOGRAPHICS, INC.) 25 October 1989 see column 1, line 1 - column 8, line 37	1,3,5, 11,13, 15,18-24
X	EP,A,0 328 298 (MARKEM SYSTEMS LIMITED ET AL) 16 August 1989 see column 1, line 31 - column 4, line 56	1,2,4-7, 9,10,13, 15,18-24

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 97/00999

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See further information

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-25

A method of producing on a substrate surface any of predetermined multi-colour diffraction/refraction effects, patterns and holograms. A non-laminated single sheet substrate having a bonded radiation-cured coating on one surface into which coating is impressed and cast-cured one of fine-line diffraction, refraction, and holographic patterns.

2. Claims: 26-27

A method of producing, from a diffraction pattern-containing flexible master sheet, a corresponding diffraction pattern product on a substrate surface

3. Claim : 28

A method of imbuing a film sheet, normally unsusceptible to embossing, with a surface having the fine-line embossed pattern of an embossed pattern-containing flexible web

4. Claims: 29-32

A method of producing, on a substrate surface, predetermined, multi-colour, diffraction effects and patterns

5. Claims: 33-38

A method of fine-line diffraction-pattern embossing

INTERNATIONAL SEARCH REPORT

...formation on patent family members

Interr nal Application No
PCT/IB 97/00999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4758296 A	19-07-88	US 4906315 A	06-03-90
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		JP 6308329 A	04-11-94
		JP 6201906 A	22-07-94
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		EP 0316407 A	24-05-89
		WO 8809252 A	01-12-88
EP 0338378 A	25-10-89	US 4933120 A	12-06-90
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		AU 3311189 A	19-10-89
		DE 68917770 D	06-10-94
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